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HOT WATER FITTING
AND
STEAM COOKING APPARATUS

BY

F. DYE

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HOT WATER FITTING

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A GUIDE FOR BUILDERS AND OTHERS

FOR THE FITTING AND FIXING OF BOILERS AND PIPES FOR THE
CIRCULATION OF HOT WATER FOR HEATING BUILDINGS
AND FOR DOMESTIC SUPPLY
WITH A CHAPTER ON
BOILERS AND FITTINGS FOR STEAM COOKING

By F. DYE

SECOND EDITION, REVISED

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E. & F. N. SPON, Limited, 125 STRAND
New York:
SPON & CHAMBERLAIN, 12 CORTLANDT STREET
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PREFACE.

THE following pages are written with the view of affording information to those who are imperfectly or little acquainted with the subjects treated, and with the object of producing a book that will be reasonable in price and within the reach of all who seek knowledge upon the subjects in question. The space, therefore, is necessarily limited, but every endeavour has been made to treat each question thoroughly; and although the information is elementary in character, there will be many hints found herein that may prove useful to the experienced and the novice alike.

Should, however, the reader seek fuller and more advanced information, he should refer to 'Hot Water Supply,' a practical treatise upon the first subject in this work, also to 'Hood on Warming Buildings,' published by Messrs. E. & F. N. Spon, Ltd.

At present there are very few specialists in this work, and the Plumber, Ironmonger and Builder are all applied to for the erection of hot-water apparatus for domestic supply. There is no disguising that many undertake this work with no more than a very superficial knowledge and experience, and this is, to a great extent, accounted for by the dearth of literary matter on the subject. It is therefore hoped that the present work will enable a more general knowledge to be distributed, and that the price will also bring it within the reach of the mechanic.

FREDK. DYE.

30 High Street,
Kensington.

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HOT WATER SUPPLY.

CHAPTER I.

BOILERS AND BOILER CLEANING.

For this purpose they are generally known by the names of "High-pressure boilers," or "Bath boilers," and the chief features to be attained in a boiler are—

1st. The largest possible bottom-heating surface.

2nd. There should be no narrow waterways or spaces if the water to be used is at all hard.

3rd. With hard water the boiler should have a large man-hole, *easily got at*, for removing the incrusted deposit or fur periodically.

There is, of course, a good amount of heat passes through the front of the boiler, especially when the fire is red, but the size of the front is always governed by the size of the fire box.

The best shaped boiler for general good results is rectangular, with an arch flue, as Fig. 1; they have good heating surface, and are roomy and easily cleaned; equally small boilers can be made with larger heating surfaces, but they can only with great difficulty be cleaned. A boiler like Fig. 1, with an 11-inch fire, would be sufficiently powerful for a medium sized residence with about three or four hot-water draw-offs; a more powerful boiler can be made by adding a leg at the back, and so making it "boot-shaped," as Fig. 2; this would, with an 11-inch fire, be sufficient for a large residence of, say, four floors with four or five taps. A boot boiler should have two lids for cleaning and access to connections. The material should be either wrought iron (welded joints) or copper; the iron is very serviceable, but copper is

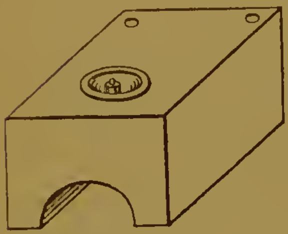


Fig. 1.

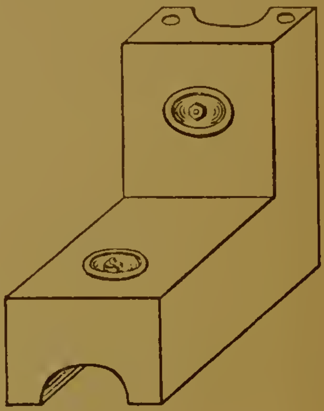


Fig. 2.

quicker heating and more lasting; the iron plates should be either $\frac{3}{8}$ inch or $\frac{5}{16}$ inch thick, the latter is not recommended for good work; copper boilers can have $\frac{5}{16}$-inch sides and $\frac{3}{8}$-inch or $\frac{1}{2}$-inch fronts; the front should be stout, as copper is soft.

In London and the south of England the water is generally highly charged with lime in solution, and the periodical clearing of the incrusted lime out of range boilers is of importance, for every practical man knows what a large number of boilers fail from neglect in this respect.

The incrustation or fur is caused by the lime being deposited when the water boils, but there is no practical means of ascertaining the quantity; but with London water it is desirable, and usually quite necessary, to clean them out every six months; they should, if in ordinary use, never be left longer than this, as the boiler is injured by the fur keeping the water from the iron; and when the boiler is much furred, the ends of the pipes get choked also, and so interfere with the circulation. The only practical means of cleaning out the incrustation is by chipping and breaking it out with a chisel held in the hand.

There are various ways of packing manlids. The following are most generally adopted:—

A stiff mixture of red and white lead is made and laid on the boiler surface, and on the flat rim of the lid, about $\frac{1}{8}$ inch thick, then take some soft $\frac{1}{4}$-inch cord (Gaskin), and coil one layer flat on the rim of the lid; but it should have been first mentioned that a mixture of red and white lead and boiled oil about the thickness of cream should first be made, to paint the surfaces with before putting the red and white lead putty on, otherwise it will not adhere well, and the rope should be dipped in this paint mixture before coiling it on the rim of the lid.

Another good method is to use the asbestos millboard collars in place of the rope, or, in a case of emergency, ordinary stout cardboard will do, but either of these must be well soaked to make them soft.

The best method of all is to use indiarubber collars, which are cut to order for 1*s.* to 1*s.* 6*d.* each. These are used without any other material or preparation, and so save considerable time; but they cannot be used if the lid is very close to the fire, as they may burn or perish.

CHAPTER II.

CYLINDERS AND TANKS.

THERE is a rather common impression that cylinders are more favourable to circulation than tanks, but the writer has never been able to detect any difference. Tanks can be sometimes used for the cylinder system when the pressure of water is light and economy has to be studied, but it is not a plan to be recommended; cylinders are capable of bearing three or four times the pressure of tanks. The following table, partially extracted from Messrs. Braby & Co.'s list, will show their tested pressures:—

Cylinders.

Vertical Pressure of Water in Pipes.	Thickness of Plate Used.
Up to 10 feet..	About $\frac{1}{16}$ inch full.
,, 50 ,, ...	,, $\frac{1}{8}$ inch full.
,, 80 ,, ...	,, $\frac{3}{16}$ inch.

Tanks.

Up to 2 feet..	About $\frac{1}{16}$ inch full.
,, 10 ,, ...	,, $\frac{1}{8}$ inch.
,, 20 ,, ...	,, $\frac{3}{16}$ inch.

Both cylinders and tanks can be used for somewhat higher pressures than the above, as they are not tested to their leaking or bursting point.

For general domestic purposes the following sizes are used :—

Number of Hot-Water Taps.	Size of Tank or Cylinder.
2 or 3	25 to 35 gallons.
4 to 6	40 „ 55 „

In ordering cylinders and tanks, it is an excellent plan, if time will permit, to order them with flanges ready fitted for the different pipe connections, as better joints can be made in less time, and it saves the trouble and expense of drilling and connecting with back-nuts inside and out.

CHAPTER III.

PIPES AND COCKS.

IRON pipes are most generally used, although lead pipes are extensively fitted in some parts of England, particularly the north; and copper pipes are now sometimes used (with copper boilers and cylinders) in high-class work.

Iron pipes undoubtedly have the chief favour for general good results and for their low cost. There are four descriptions used, viz.: red steam, galvanised steam, black gas, and galvanised gas; but any fitter who wishes to have his work recommended will not use either of the two latter, as they are not suited for any except a cheap and temporary class of work.

The advantage that galvanised pipe has over the plain iron pipe is that the former does not so readily rust and discolour the water; but care must be always taken to see that the pipe is galvanised inside as well as outside. The process of galvanising is said to be a little injurious to the pipe, but with a fair quality it will never be noticeable.

The most satisfactory sizes of pipe to use will be spoken of as each description of apparatus is explained.

Lead circulating pipes have several disadvantages. 1st. They must be very stout, or they will stretch with the pressure (and by their own weight sometimes) and sag down, and even stout pipe must be hooked up in a thorough manner. 2ndly. The pipe is much more expensive than iron (but it is cheaper to run or fix), and again, the pipes nearest the fire have been known to melt when furred or if they accidentally get empty; and with lead circulations only "wiped" joints should be made. And, lastly, only screw-down cocks can be used with lead hot-water pipes, as the concussion caused by the quick-shutting plug-cocks is apt to stretch or bulge the pipe.

NOTE.—Never neglect to look through iron pipes and fittings before fixing them, to see they are quite clear, as an obstruction is a difficult thing to find after the work is completed.

Cocks or taps are of almost numberless descriptions and qualities, but money is well invested in procuring and using good quality taps. There are many good makes of the ordinary plug-cocks, but it will be found that the gland plug-cock gives the best results as regards wear; but it is best to use some description of screw-down cock for the ground-floor if the building is a high one, as the pressure causes quite a violent jar or concussion if the tap is closed sharply, and if opened full the outrush of scalding water is not always pleasant. There is a rather new description of screw-down tap that the writer is in favour of, that can be had to open or close with a half or one turn only; some of them are similar in construction to the ordinary screw-down cock, but the thread is coarser, and consequently closes or opens quicker. The ordinary plug-cock can, however, be used for high pressures or for lead pipe by partly closing the passage in the tail (the part that is screwed), or by ordering them with only $\frac{3}{16}$-inch or $\frac{1}{4}$-inch bore in the tail; most makers stock them made in this manner for high-pressure work.

The cold supply to the tank or cylinder should always have a stop-cock in it, as will be explained, but care must be taken *not to use any but a full-way cock;* that is, a cock that has a full-sized bore clear through it, otherwise the effect in the flow of water will be as bad as having a small-sized pipe throughout; and this cock should always be made with a loose key or handle, that it may not be used except at proper times and by proper persons.

CHAPTER IV.

DESCRIPTION OF APPARATUS ON THE TANK SYSTEM.

THE reader may doubtless have no desire to be made acquainted with the very old one-pipe system which is now but rarely met with even in old buildings; it was undoubtedly the first system introduced for the supply of hot water above the level of the kitchen boiler; its dangers and disadvantages were numerous, and would be quite unsuited for modern ranges, no tank being used, consequently, unless the boiler held

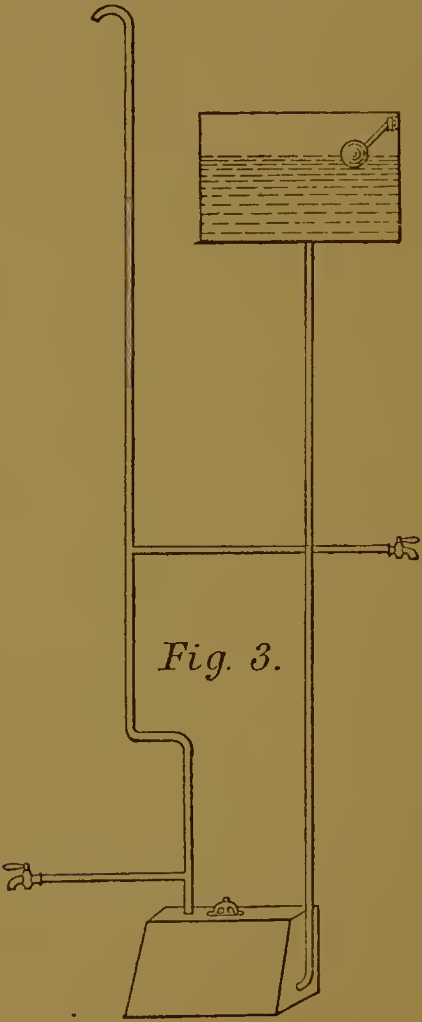


Fig. 3.

some 15 or 20 gallons, the supply would be very limited; it was only suited for the old open ranges with large fires. Fig. 3 shows the simple method in which this system was carried out.

The oldest system at present in use, and which is still fitted extensively, is that which has a tank fitted somewhere above the highest draw-off service. Fig. 4 shows the general arrangement.

The boiler is situated in the range at the back of the fire; from the top of the boiler (near the back) is carried up the flow pipe to the tank: this pipe should terminate about 6 inches from the top of the tank, either connected through the side or projecting up through the bottom (as shown). This flow pipe should be given a rise wherever possible, though, if necessary, it can be run horizontally, along a ceiling for instance, but it must on no account be allowed to dip or descend anywhere; and *great care must be taken to see that it does not project through inside the boiler*, not even the eighth of an inch, or the boiler will not fill when charging, and there will be noises of an unpleasant character caused thereby.

The return pipe is brought down from the lowest point in the tank to the boiler, either being carried in at the side near the bottom or projecting through the top (as shown); it should terminate about 4 inches

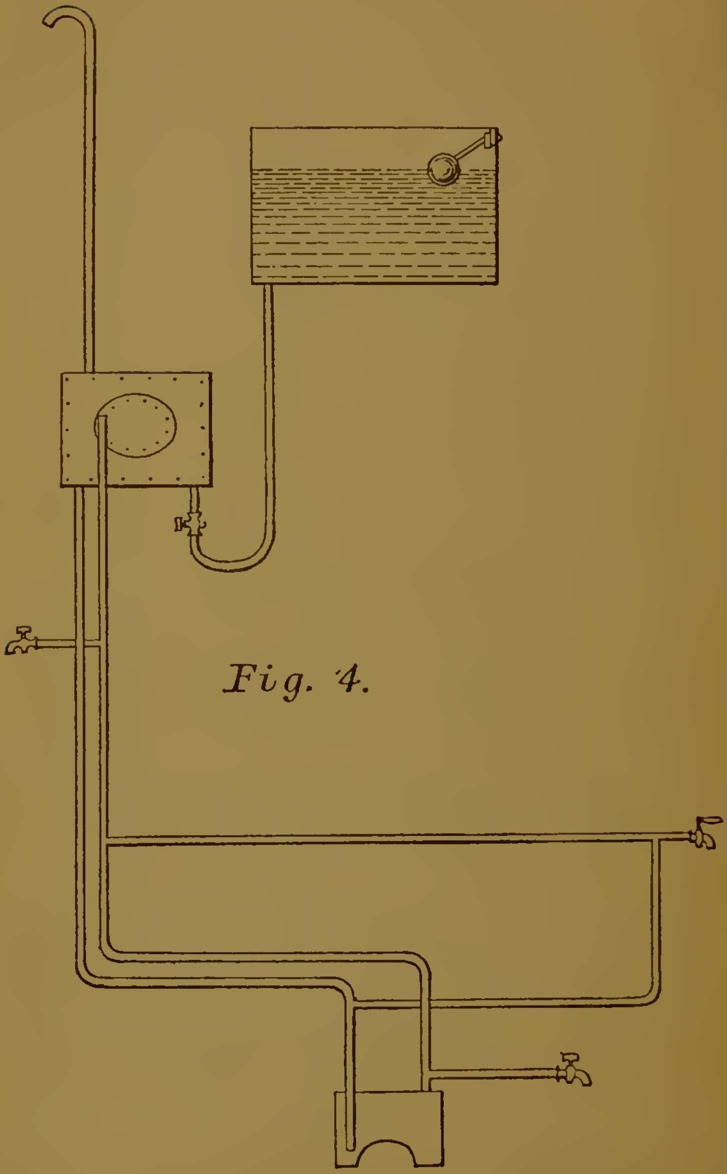


Fig. 4.

from the bottom. This pipe must descend all the way, and not be allowed to rise anywhere. It will be noticed that the flow pipe is spoken of as proceeding from boiler to tank, and the return pipe from tank to boiler.

Connecting pieces, generally known as "connectors" or "longscrews," should be used in connecting all pipes to the boiler or tank, and it is a wise and often profitable plan to use them freely wherever they are suitable, as, should occasion arise, it is very trying to have to cut a pipe to remedy some small fault, such as a leak, &c. Let *bends, and not elbows,* be used in all circulating pipes to make the circulation as free as possible, but of course there are occasions when bends cannot be judiciously used; this advice only applies to the pipes in which the water circulates.

For a small apparatus the flow and return may be 1-inch pipe, with ¾-inch draw-offs, and ¾-inch cold supply, but the bath service should be 1-inch, as a slow-filling bath is a great annoyance; but wherever the extra cost will be allowed it is preferable to use a 1¼-inch flow and return with hard waters, as 1-inch pipes are sometimes so furred in five or six years as to require renewing. If 1¼-inch is used the cold supply might with advantage be made 1-inch;

the other services would be the same as just explained.

The draw-off services *are all taken off the flow pipe*, and are connected with the usual tee pieces, and at least one connector should be used in each.

The cold supply can be carried in lead pipe, there being no objection to this, and good "blown" joints may be made if the fitter cannot make a "wiped" or "plumber's" joint; there should be a stop-cock in this pipe to avoid the necessity of emptying or plugging the cistern, and this cock should have a loose key, to be kept by some responsible person that it may not be tampered with. A particularly necessary feature in the cold-supply pipe is the dip or syphon, to prevent the hot water passing up into the cold cistern; this syphon should be about 6 to 9 inches deep (as shown). There is no occasion whatever to carry out the old plan of using a "feed" or "supply" cistern; the cold-supply pipe can be carried direct from the house cistern to the tank, but, as explained, it must be syphoned (dipped) on the way and a stop-cock should be provided.

The expansion pipe is that which is carried from the highest point in the tank to some 3 to 6 feet above the cold-water cistern, and is terminated by either turning it over to drip into the cold cistern or by carrying it through the wall to drip outside. The latter is the proper plan, as if turned over the cistern it must be borne in mind that, if the boiler is a powerful one, hot water may occasionally be ejected from the expansion pipe, and this would make the cold water unpleasant in the summer months. This pipe must on no account project through inside the tank.

There is an objectionable feature often met with in long draw-off services. The water lying in a single pipe soon becomes cold, and then has to be drawn off before any hot can be obtained from the circulating pipes. The writer has known instances where as much as 2 gallons has had to be drawn off (but this is not an objection in the bath service, as a certain amount of cold water is nearly always required).

The way to remedy this is to return the draw-off service (with a smaller-sized pipe will do) into the return pipe, thus making it into what is known as a secondary flow and return. The hot water will then circulate through it. A check valve must be put in the secondary return, otherwise cold water will proceed from the return pipe to the tap when the latter is opened.

The disadvantages of this system are as follows :—

1st. The danger in being able to draw all the water out of the apparatus should the supply fail.

2nd. Loss of heat by the tank and circulating pipes being in cold positions.

3rd. Greater time in getting a body or quantity of hot water.

The loss of heat can be obviated by fixing the tank and pipes in as warm positions as possible, or by covering them with felt or encasing them with wood; but if the pipes or tank are cased, *the casing must be packed with some non-conducting material*, such as cow hair (plasterer's hair), felt, slag wool, or sawdust, &c.; and if the circulating pipes are carried up the casing that contains the soil pipe and other pipes of the house, *great care* must be used to prevent their touching or affecting each other.

CHAPTER V.

DESCRIPTION OF APPARATUS ON THE CYLINDER SYSTEM.

THIS is a modern system, generally supposed to be of American origin. In this arrangement the boiler is, as usual, situated at the back of the range fire box.

The cylinder is situated as near to the boiler as is convenient, and generally only about 1 to 2 feet above the level of the boiler, *and all draw-offs are taken from above the cylinder.*

Fig. 5 will acquaint the reader with the details generally, and it will be noticed that the flow and return are connected to the boiler in exactly the same manner as in the system last described, and from the boiler they are carried into the side of the cylinder, the flow about 9 inches up from the bottom, and the return about 6 inches below the flow. The flow pipe is then continued up inside the cylinder half way to the top. Sometimes these two pipes are carried in through the bottom, the same as illustrated in the last system, but it is not the best plan, and as these pipes rarely exceed some 10 to 14 feet in all, it is best to always use 1¼-inch pipe, as the difference in cost for this small quantity is but trifling. The remarks already made in reference to using "connectors" or "longscrews" are of course equally applicable to this system.

From the top of the cylinder is carried an expansion pipe, but which in this system is called the "rising main." This terminates above the level of the cold cistern as shown, and as already explained, it is better to take it through an outside wall than to

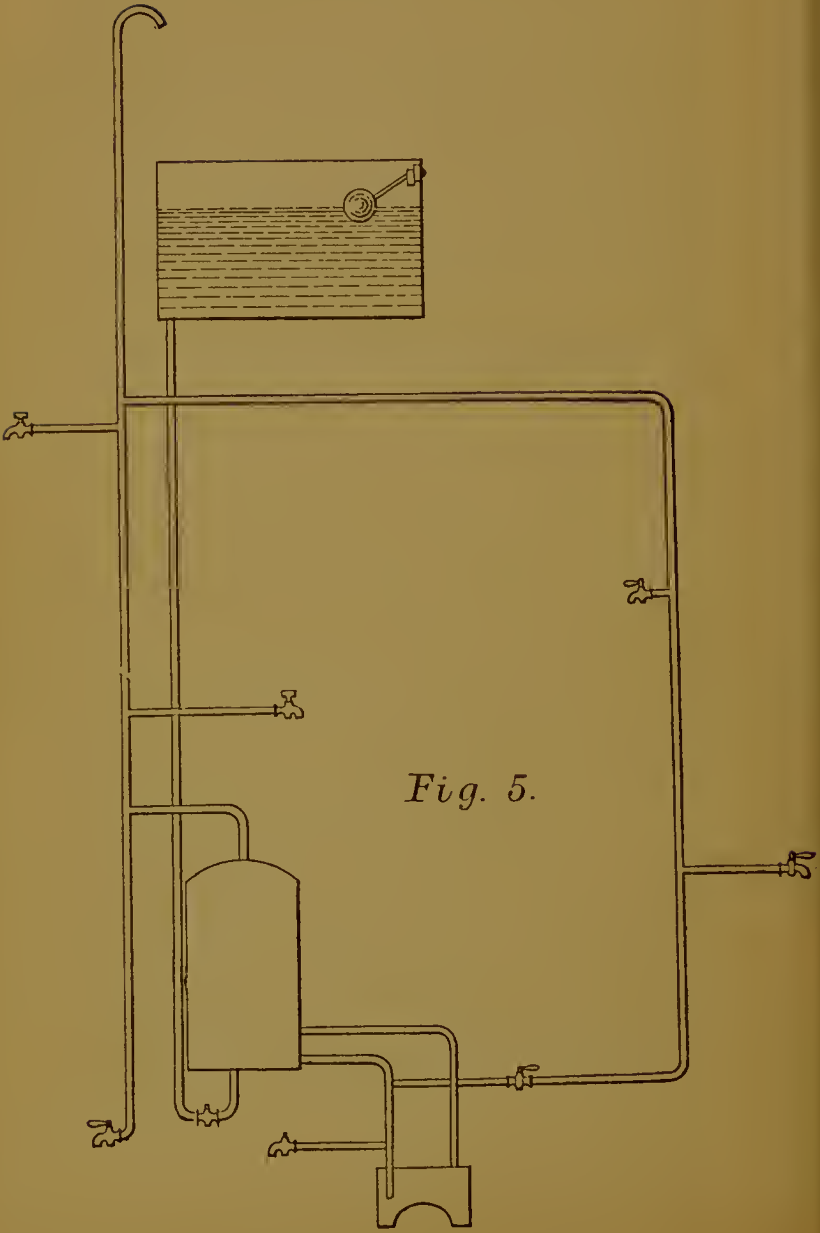


Fig. 5.

turn it over the cold cistern. From this pipe is taken all the draw-off services. Or perhaps it would be better to explain that this pipe need not be carried up direct, but can be run in the most convenient direction for the draw-offs, but must on no account descend or dip anywhere; it should be given a rise wherever possible, the same as a flow pipe, and it must not project through inside the top of the cylinder.

If this rising main is very long, or has much horizontal work in it, it is desirable to return it to get over the stagnant water difficulty, and so making it what is generally known as the "secondary flow and return." This return commences at some convenient point below the cold-water cistern, and can be carried back in a different direction to which the rising main is taken, and draw-off services can be taken from it if desired; but if no draw-off services are taken from this return, it can be carried in a smaller-sized pipe, for in this case the only object to be attained is to keep the water on the move, so that it may not become still and cold.

Fig. 5 shows the usual method adopted in connecting this secondary circulation, but there is a distinct fault in the lower connection entering the primary return pipe. This admits of cold water passing up to the nearest taps when they are opened, unless a check valve is used. *It is better to return into the cylinder no more than 6 inches from the top.* This will enable the hottest water to be drawn from any tap irrespective of its position.

The cold supply is brought down by the most direct route from the cistern to the cylinder, and should be connected in the bottom of the latter with the necessary syphon and stop-cock explained in the last chapter. The stop-cock in this system should be put as near the cylinder as possible, as it is oftentimes annoying to have workmen walking up and down stairs to turn the water on and off; and be sure to have a cock with a loose key or handle, for the reasons already given.

Now arises the question—Suppose the boiler wants cleaning out, how is the cylinder to be emptied? The most simple and cheapest plan is to put in a medium quality draw-off cock somewhere under the cylinder, either in the cold supply or the flow or return, *but this cock* MUST *have a loose key*, the same as the cold-supply stop-cock, and the two keys must be kept by some responsible person, *to be only used when absolutely necessary.* Instances are often to be met with where no provision has been made to empty the cylinder when occasion demands. The only methods that can then be adopted are to either loosen the boiler manlid and let all the water run out into the kitchen, or take the top of the cylinder off and syphon its contents out.

CHAPTER VI.

EXPLOSIONS, SAFETY VALVES, GENERAL DIRECTIONS, ETC.

It is a fortunate thing that explosions of range boilers are of rare occurrence, as the results are disastrous and oftentimes fatal. The chief cause is frost; next comes failure in water supply; thirdly, the injudicious use of stop-cocks; and lastly—a very rare cause—stoppage of pipes by incrusted deposit

Frost very often attacks the circulating pipes when the water is cold, and when they are carried in cold casings or roofs without being covered with felt, but no doubt the danger is often obviated by the ice melting after the fire is lighted, and before sufficient power has been generated to burst the boiler; or what is more often the case, no doubt, some one may open a tap between the ice and the boiler, and this would let any steam, &c., escape, and it would also warn the person that something was wrong. The remedy is to have the pipes protected from the cold in some of the ways described.

The danger in the failure of water supply is as follows—either by extra quantity being drawn, or by an unseen leak the water gets exhausted down to the lowest draw-off (or lower if the leak is below this point), and the fire soon evaporates what water remains in the pipes and boiler; should the failure not be noticed, then the boiler, when empty, becomes red hot. Should the cold water flow in while the boiler is in this condition an explosion may take place, as steam is generated so fast and in such prodigious volume that the pipes will not admit of it passing away quick enough, especially as they (or one of them) are charged with the water that is flowing down. The reader will readily see that an explosion from this cause is a very unlikely thing if the apparatus is on the cylinder system.

Stop-cocks are indeed a great source of danger, if placed in the circulating pipes. *Under exceptional circumstances* a stop-cock may be put in *one* of the circulating pipes, but never in both. It is quite recently that a practical man lost his life in this way; there were stop-cocks in both flow and return, put there with the object of stopping both pipes when the boiler wanted opening, and so save emptying the cylinder or tank. The accident in this instance was caused by the fitter inadvertently closing both cocks after charging the boiler and lighting the fire, the explosion taking place while he stood in front waiting to see if everything went right.

An explosion from the pipes being stopped with incrusted deposit has never met the writer's experience, but he once met with an instance where an explosion would have assuredly taken place had the boiler not been provided with a safety valve, as both pipes were quite stopped without any one's knowledge, and the owner only called attention to it because he was annoyed at the safety valve continually blowing off, &c.

The use of a safety valve is to be highly commended, as it practically obviates all danger, and they can now be obtained of good and reliable make at a very low cost, and really no boiler should be without one.

In fitting a safety valve there is an amount of care and consideration needed, or it may be found to be useless should danger arise. The strictly proper place to fix it is direct into the boiler, but this can seldom if ever be done, as it ought to be fixed in sight where it can be kept clean and be tested occasionally if desired. This, with kitchen-range boilers, can only be done by connecting it by means of a pipe; this pipe should be at least 1 inch, and it should be inserted in the boiler where the fitter can readily feel if it is clear when he opens the boiler for cleansing purposes, &c. The only objection to using a pipe is that it may become stopped with the incrusted lime if care is not used. This pipe should never exceed 2 feet if possible, and may best be screwed through the top plate of the boiler, so as to project down about an inch inside.

Referring to the general circulation and services, there is a practice adopted only too commonly, by builders and others, of either chasing the walls for the pipes to be recessed in and afterwards plastered over, or in new buildings running the pipes on the brickwork before the plasterer has done his work; the evil of this is that should any alteration or repair be needed, much damage has to be done to expose the pipes, and oftentimes serious injury to wall decorations, in searching for and finding them.

Another serious error is in carrying circulating, or, in fact, any water pipes outside buildings; this is wrong in principle, and on no account should it be done, however well the pipes may be cased and packed.

When an apparatus is completed, the fitter should not leave it for good until he has charged it with water and thoroughly tested it with the fire alight, to see that the circulation is perfect and that no leaks exist; of course a new apparatus never gives such good results on the first trial as it will after a week's firing. It can be calculated that it will not work more than half as well, as the water and everything in connection with and surrounding it are quite cold.

Should a leak or "weep" be found, it is hoped the fitter will not fall into that unworkmanlike habit of leaving it to "pick up" (rust up); he should remedy it at once, as, should it be noticed afterwards, it will prejudice the whole work.

The great aim and object should be to provide an apparatus that will give a supply of hot water *in good time in the morning.* A poor apparatus will heat water by mid-day and evening, but it is in the morning when so many fail, when baths, &c., are needed; it is thought the directions given herein will put the fitter in possession of knowledge sufficient to overcome this difficulty.

In conclusion, the writer feels that he cannot impart all the information he would do, the space being so limited; but for those who seek more advanced knowledge, and details of other more unusual and complicated systems, &c., he must refer them to the larger works upon the subject, referred to in the preface of this book.

HOT WATER HEATING.

CHAPTER I.

INTRODUCTION AND GENERAL REMARKS.

It would be difficult to say when this method of heating was first introduced, but there is not the least doubt that it is of very early origin, although the means then adopted must necessarily have been very rude and imperfect. It has often been thought that heating by means of hot water would have become much more general for domestic purposes than it is, as it may be considered economical, and the low-pressure system is well adapted for this purpose, as will be explained. There is no doubt that prejudice has greatly to do with its non-use, as it is difficult for the English mind to be satisfied with warmth which has not the sense of cheerfulness and comfort that is derived from the open fire-grate, notwithstanding that this later appliance provides for abundance of labour, dirt, dust, smoke, and in many cases a shameful extravagance in the consumption of fuel.

Some of the advantages of hot-water heating are that there is only the one furnace to attend to, and the labour and dirt is reduced to a minimum ; the heat is regular, or can be increased or decreased in a few moments at will ; the pipes or radiators can be placed wherever it is most desirable, that is to say, in the coldest parts of an apartment, or where draughts enter, &c., and it has the advantage over warming by hot air in the fact that the air is not robbed of its moisture, neither is there any unpleasantness arising from particles of dust and floating matter becoming scorched or burnt. It is to be wondered that these advantages are not more appreciated ; there are practically no disadvantages, nor is there any danger.

These remarks refer chiefly to warming our dwelling-houses, &c., by hot water. This method is almost invariably used and with every possible success in our green-houses, conservatories, and for all horticultural purposes, also in churches, public places and large institutions.

For domestic purposes of no magnitude, hot-water coils, pipes or radiators (low-pressure) can advantageously be fitted in connection with the hot-water supply system, which is heated by the kitchen-range boiler. This will be further described, as there are various uses to which it can be adapted with profit, such as placing a coil in a closet for airing linen, &c., or for drying purposes on a small scale; but it is not desirable to attempt to heat a conservatory or green-house from a kitchen boiler, as an almost insurmountable objection presents itself in the fact that when the warmth is most needed, that is at night, the kitchen-range fire is out.

The most useful purpose to which the writer ever adapted the kitchen boiler, in addition to the hot-water supply system, was by running a distinct flow and return service from the boiler to three bedrooms, in which coils of suitable size were placed. This was in a gentleman's country house, and the purpose was as follows:—When the house was occupied during the summer months, the coil service was shut off by means of stop-cocks placed in both the flow and return near the boiler (there was no danger in doing this, as the hot-water supply was not interfered with or stopped). For the greater part of the winter the house was left in charge of two or three servants, consequently there was no great demand for hot water, and the coil services could therefore be brought into action, and so keep the bedrooms aired during the damp and cold weather, ready for instant occupation.

Of course, whatever heating apparatus is connected with the range boiler must necessarily be upon the low-pressure system, and as the high- and low-pressure systems vary so greatly, they will be treated under distinct headings.

CHAPTER II.

THE LOW-PRESSURE SYSTEM. BOILERS.

The different patterns and makes of boilers for this purpose are almost beyond calculation, and it is certainly impossible to do more in this instance than to draw the reader's attention to, and describe those most generally used, and which have been found generally good in results.

It will be as well to first speak of a form of boiler that is eminently adapted for small purposes, and that is what are generally known as independent boilers; in these the boiler and furnace are constructed in iron so as to form one structure or apparatus, and thus do away with the expense and trouble of brick setting, they also have the advantage of being portable. They are made in two forms, viz. those that require regular stoking, and those that are made with a self-feeding hopper or attachment; these are all fitted with the necessary sockets for connecting with the flow and return pipes, and are also provided with the nozzle to which the iron smoke or flue pipe is attached, they are also commonly fitted with mud or hand holes (which have screw plugs) for cleaning and flushing purposes.

Fig. 1 shows the cheapest form of independent boiler, made in cast iron, and the following is the average price and capacity of this make:—

Size of Boiler, body only.	Heating Power. 4-inch Pipe.	Price.
13 × 13 × 12 inches.	50 feet.	£3 0 0

Cast iron is a material that is now largely used for boilers even of large size. In America the cast boiler is used to the exclusion of wrought iron, and there is much in its favour. Fig. 2 shows a more efficient boiler; this is wrought iron, and the illustration shows the self-feeding hopper or fuel chamber attached at top. The whole apparatus being conical, there is no fear as to the store of fuel becoming fixed and not falling, and the contents of the fuel chambers are sufficient to keep the fire going through the night without attention. The following table gives the prices and capacities of a medium quality or make;

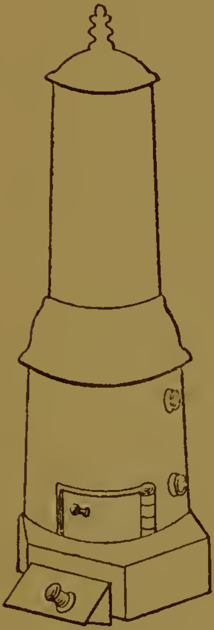


Fig. 1.

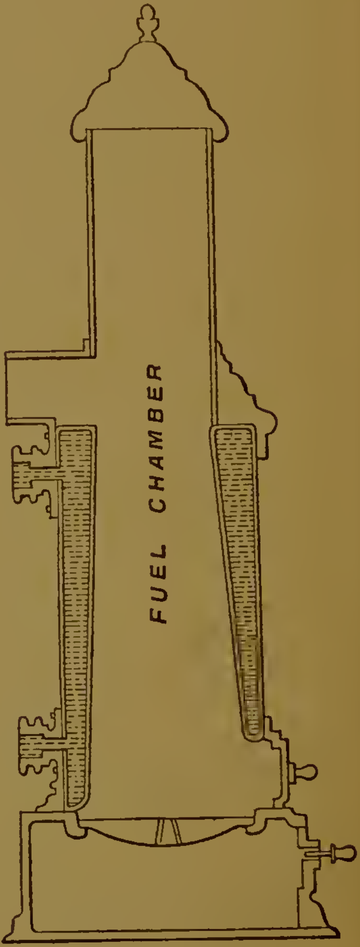


Fig. 2.

they are to be purchased at both less and higher prices than these :—

Boiler and Hopper.	Sockets.	Heating Power. 2-inch Pipe.	Price.
48 × 12	1¼ inch	200	£3 17 6
54 × 14	1½ „	300	4 7 6
64 × 16	2 „	600	6 15 0
60 × 18	2 „	900	12 15 0
66 × 21	2 „	1400	16 15 0

and still larger sizes up to 4000 feet, the larger sizes having cross tubes.

It must be understood that any caking fuel such as ordinary coal is not suitable for these self-feeders. Coke is best adapted, and should be broken moderately small; but any boiler of this description can be had without the self-feeding arrangement, and the cost is about ¼ or ⅕ less.

Fig. 3 shows another and cheaper form of boiler than the last, and is made especially for green-houses and conservatories of medium and small size; the special and advantageous feature in this boiler is its shape, which permits of its being built in the wall of the building, with the stoking and cleaning doors on the outside and the pipe connections inside, thus ensuring cleanliness and avoiding the necessity of entering the building for stoking purposes. The prices and sizes of a medium quality are as follows :—

Boiler.	Sockets.	Heating Power. 2-inch Pipe.	Price.		
18 × 12	1½ inch	350	£3	15	0
24 × 12	1½ "	400	4	10	0
24 × 14	2 "	550	5	10	0
30 × 14	2 "	650	6	10	0
30 × 16	2 "	850	8	10	0
36 × 16	2 "	1000	10	0	0

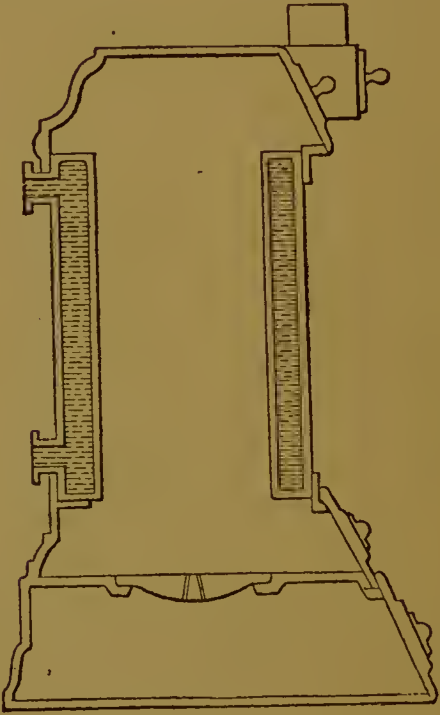


Fig. 3.

Fig. 4 is another still more powerful form of independent boiler quite suited for horticultural purposes on a somewhat extensive scale, and is very compact; but as it is generally necessary to make a boiler pit or house for this latter purpose, the brick-set boilers are more commonly used for economical reasons, as the furnace can be made and the boiler set very expeditiously while the building operations are progressing.

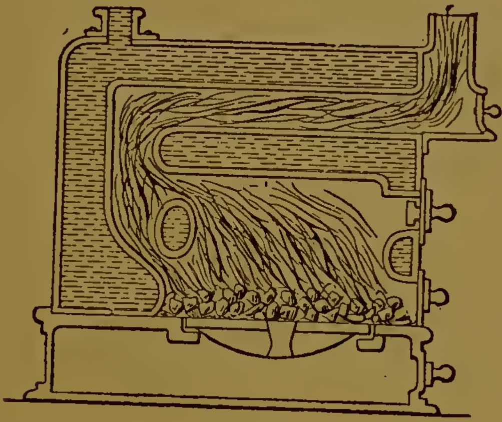


Fig. 4.

The following are prices and sizes of this description of boiler in $\frac{5}{16}$-inch plate; $\frac{3}{8}$-inch plate is about 15 per cent. dearer :—

Size.	Heating Power in 2-inch Pipe.	Price.
30 × 24 × 33 inch high.	2200	£23
42 × 24 × 33 ,,	3000	30
54 × 44 × 33 ,,	4200	37

Independent boilers are especially adapted for use where no provision for this purpose has been made in building, or in instances where there is a probability of the boiler needing to be moved for any reason whatever, and an independent boiler is generally best in instances where an iron pipe-flue has to be erected, although there is no reason why an iron flue should not be used with a brick-set boiler.

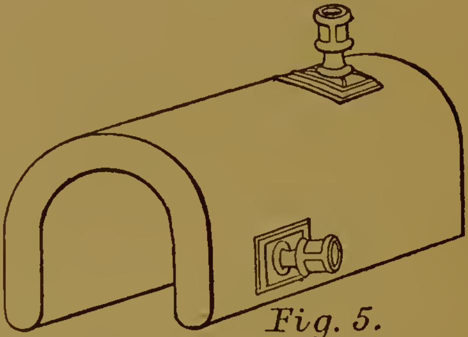


Fig. 5.

It should be mentioned that the boilers spoken of in "Hot Water Heating" are wrought iron with welded (forged) joints, with exception of the first independent boiler mentioned in Chapter II., which will be found described as being made wholly of cast iron; but to prevent misunderstanding, it should be also explained that with wrought-iron independent boilers it is *only the boiler itself* that is wrought iron;

the casings, furnace fittings, &c., are of cast iron, which is much more suited for such purposes than wrought iron.

Fig. 5 shows the most common form of boiler that requires to be set in brickwork, and is known as a "Saddle" boiler owing to the shape. There are various additions made to this boiler to increase its power (and which of course increase the price), such as putting water tubes across from side to side, &c., but this short treatise will not permit of more than the most general forms being described. The sizes and prices in $\frac{5}{16}$-inch plate average as follows :—

Size inside Arch.	Heating Power. 4-inch Pipe.	Price.	Price of Fittings.
8 long × 10 wide	200	£2 7 6	£2 12 6
24 " × 12 "	300	3 7 6	3 2 6
33 " × 12 "	400	4 10 0	3 10 0
36 " × 14 "	500	5 7 6	3 12 6
36 " × 16 "	600	6 7 6	3 12 6
42 " × 18 "	800	9 0 0	4 0 0
48 " × 21 "	1000	11 7 6	4 17 6
60 " × 24 "	1500	15 17 6	6 10 0

Fig. 6 shows the most general method adopted for fixing saddle boilers. It is a method invariably used by the writer, as after following out many suggestions and making many experiments, this has been found the best in general good results.

The base is first built up to the level of the bottom of the boiler, and the ash pit is formed and the bars set in; the bars should be two-thirds the length of the boiler, as shown. The back end must then be checked by partially stopping the flue-way with firebricks, as at "A" in Figs. 6 and 7. This greatly reduces the draught, and unless this is done it permits of excessive consumption of fuel unless great care is used in the stoking. A damper must be put in the flue to regulate the draught in any case.

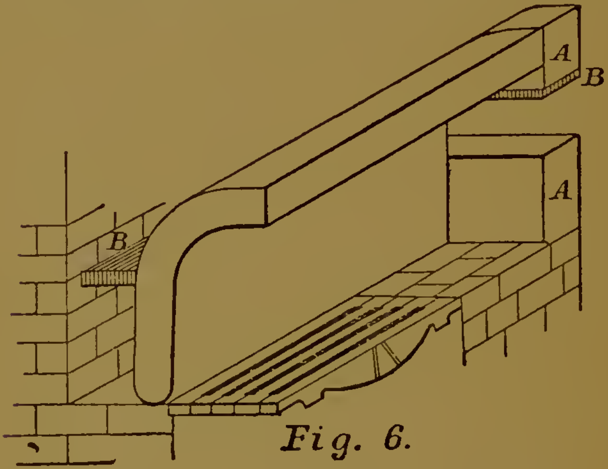


Fig. 6.

As the flame leaves the arched flue between the check ends A A, it must be made to divide and return each side of the boiler by means of the midfeathers or plates "B," which can be either iron or firebrick. This midfeather extends across the back, and up each side to within about 4 to 6 inches from the front, thus permitting the flame to pass from the lower outside flues up to the top, along where it travels to the up-flue or chimney at the back. By this arrangement the flame travels *on each side of the boiler* in the direction indicated by the arrows in Fig. 8. To permit of the flues being cleaned of the soot that is deposited (hard coal or mixed coal and coke being the fuel very commonly used, soot doors must be fitted in the front brickwork where marked S S S in Fig. 7.

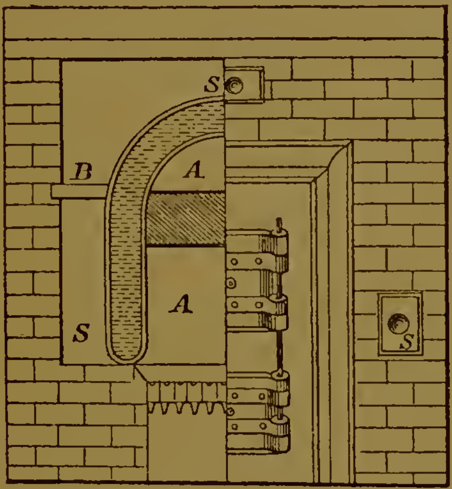


Fig. 7.

All brickwork in connection with the flues should be built in fire-bricks, and the average width of the flues is 4 inches. The following is a table of the length of pipe that saddle boilers of the ordinary dimensions will heat. By ordinary dimensions is meant the usual width and height for a certain length; for instance, an 18-inch boiler is usually 10 inches wide and 11 inches high, and will heat 200 feet of 4-inch pipe or 400 feet of 2-inch pipe; but should it be made wider or narrower, the results will differ accordingly.

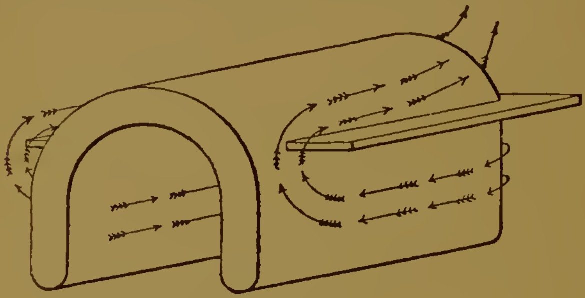


Fig. 8.

Size of Boiler inside Arch.	4-inch Pipe.	3-inch Pipe.	2-inch Pipe.
18 × 10	200	280	400
24 × 12	300	400	600
30 × 14	425	..	850
36 × 16	600	800	1200
42 × 18	800	..	1600
48 × 21	1000	..	2000
54 × 21	1150	..	2300
60 × 24	1500	2000	3000

It will thus be seen that a saddle boiler of given size will heat twice the length of 2-inch pipe than 4-inch pipe, and one-third more 3-inch pipe than 4-inch pipe, or one-third less 3-inch pipe than 2-inch pipe; this rule can be safely relied upon.

Prices are quoted with the object of making the reader somewhat familiar with the cost of such articles, and also that the book may be useful for reference and for estimating purposes.

NOTE.—*All prices quoted are subject to a trade discount* if the goods are purchased at the makers.

CHAPTER III.

PIPES AND FITTINGS, JOINTS, RADIATORS, ETC. (LOW PRESSURE).

THE pipes and fittings for low-pressure radiation are of cast iron, socketed at one end very similar to cast rain-water or smoke pipe, but much stronger than either of these, being of about $\frac{1}{4}$-inch substance, and of a better quality metal. The sockets are especially strong to withstand the force used in packing the joints, and the pipe has rings or bands cast upon it as Fig. 9.

The fittings most commonly needed are as follows —Fig. 10, elbow. Fig. 11, elbow syphon, made with two, three or four outlets. Fig. 12, syphon bend, made with two, three or four outlets. Fig. 13, outlet syphons, two, three or four way. Fig. 14, T piece. Fig. 15, double elbow. Fig. 16, Y piece. Fig. 17, H piece. Fig. 18, coil-box end. In addition to these are many other fittings not so commonly used, viz. cross pieces, coil syphons, reducing sockets, elbows and T pieces, "S" pipes, caps, &c. &c. These illustrations are merely outline, that the reader may recognise the fittings by name. They are all made with or without sockets at either or both ends, &c., to suit any special requirement.

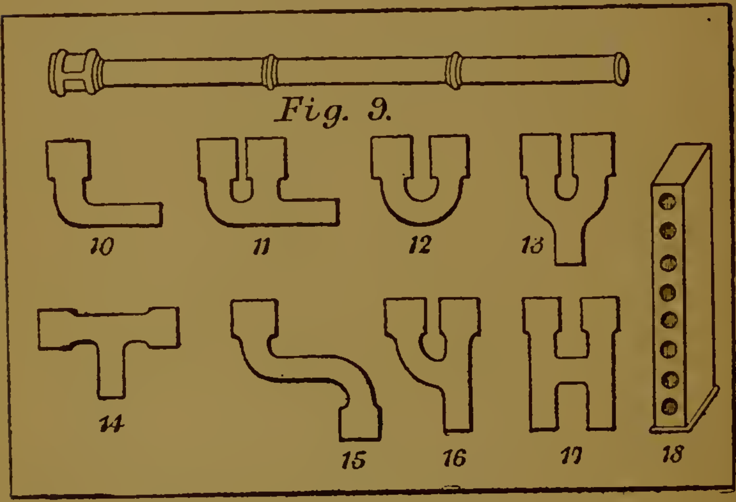


Fig. 9.

Cast iron has superior radiating or heat-diffusing power to wrought iron, and is therefore best suited for this purpose. Pipes that are exposed where people might be apt to touch them, and so pain themselves if the water was near boiling point, are sometimes made with ribs or gills cast upon them, either lengthwise or across. This is an adaptation of the principle of the gill stove, used so extensively in warming waiting-rooms and other such frequented places. These gills act as heat collectors and diffusers in this way: the pipe itself becomes very hot; this heat immediately travels into the gills by the rapid conductive power of the iron, and from the gills it is radiated. There is no heat lost whatever by this transference, and it has the advantage of presenting an extended very warm radiating surface instead of a smaller surface intensely hot; or in other words, the same amount of heat is diffused in each case, and in one instance it is from a large warm surface, but in the other form a small intensely hot surface.

The supply cisterns for holding a supply of water to make good the loss occasioned by evaporation, and which may therefore be looked upon as being for filling purposes, are made in a great variety of designs, ornamental and plain, generally in cast iron, provided with a lid, and the average capacity is about two gallons.

The air-cocks are small brass nozzle cocks, which are inserted at any high point where, in charging the apparatus, the air could become confined, as, for instance, the highest point in the flow pipe or at the tops of coils or radiators.

The following are list prices of pipes and fittings, which are subject to trade discount if purchased from manufacturers :—

	2-Inch.		3-Inch.		4-Inch.		
	s.	d.	s.	d	s.	d.	
Cast hot-water pipes	1	4	2	0	2	6	per yard.
Trough pipes, 6 inches wide..	6	3	7	6	8	9	,,
,, ,, 9 ,, ,, ..	..		9	6	11	6	,,
Elbows, one socket	1	8	2	8	3	4	each.
,, two ,, ...	2	0	3	0	4	0	,,
Double elbows	5	0	7	0	9	0	,,
Syphon end	2	6	4	0	5	0	,,
,, ,, 3 way	5	0	8	6	11	0	,,
,, ,, 4 way	6	9	11	0	15	0	,,
Outlet syphon	4	3	6	9	9	0	,,
,, ,, 3 way	6	9	10	0	14	0	,,
Elbow syphon, 2 way	4	3	6	9	9	0	,,
,, ,, 3 way	6	9	10	0	14	0	,,
,, ,, 4 way	8	0	14	0	18	6	,,
Tee pieces	2	6	4	0	5	0	,,
"Y" pipe	4	3	6	9	9	0	,,
"H" pipe	5	6	8	6	11	6	,,
Throttle valves	10	6	12	6	14	6	,,
H pipe or tee piece, fitted with two valves	27	6	35	0	42	6	,,
Diaphragm screw valve	15	0	19	0	24	0	,,
Pipe rests, single or double ..	0	4	0	5	0	6	,,
Evaporating trough for 4-inch pipe to lay in, 6 feet long ..	..		..		37	6	,,
Steel caulking tools	1	6	2	0	2	6	,,
Coil ends or boxes, with sunk sockets	1	3	3	9	5	6	per hole.

The following are the most general methods of jointing the ordinary description of hot-water pipes:—First make a mixture of red and white lead and boiled oil to use as a paint; then make a stiff mixture of red and white lead, without the oil, about the consistency of putty. Paint the spigot end of the pipe and inside the socket with the paint mixture; then after putting the ends together, pack round with the red and white lead putty and yarn, the yarn to be soaked in the paint mixture before using it. There are special tools for packing in the yarn (which is coiled round the pipe) called "caulking tools," which are somewhat similar to bent cold chisels, but very blunt, the edge being from $\frac{3}{16}$ inch to $\frac{1}{2}$ inch wide. These are used with a hammer to drive the packing tight in the socket. It will be understood that usually there is but little or comparatively no pressure existing in the pipes of a horticultural apparatus, very different to the pressure exerted in an apparatus that extends up several floors.

A second method is to take fine iron borings and mix them with a solution of sal ammoniac. Then take a 30 to 36-inch length of rope yarn, coil it round and well caulk it into the socket, which it should half fill, then caulk in the iron cement. Only just sufficient of this cement should be made at once, as it will not keep. This is practically a rust joint, and is cheaper than the first-mentioned method.

A joint to be highly recommended, and which is fast coming into use, is the indiarubber ring. This is used without any preparation, it being stretched over the spigot end, which is then forced into the socket. These rings are sold by weight at about 4*s.* per pound, and can be used by an unskilled person. The material is more expensive than lead and yarn, &c., but the saving of labour and time is very great.

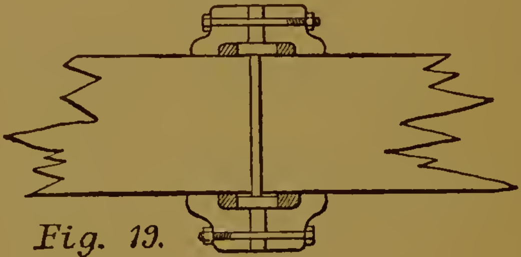


Fig. 19.

There are now several patented joints which deserve great commendation, as not only are the joints perfectly tight, but are most substantial in point of strength also, and for jointing pipes to the box coil ends they are unrivalled. Fig. 19 is a section of Jones & Attwood's patent joint, consisting of two loose flanges, one iron ring, two indiarubber rings, and two bolts. As the flanges are drawn together the indiarubber rings are compressed tightly round the pipes about one inch from each end, and it will be noticed that the pipes used are quite plain—that is to say, without sockets—so that any length can be used, and good joints can be made even if the ends of the pipe are rather rough; there is a saving effected in the cost of the pipe. The list prices of the joints are—2-inch 10*d.*, 3-inch 1*s.* 1*d.*, 4-inch 1*s.* 5*d.* each. Indiarubber joints allow for expansion and contraction without strain.

The following table of weight and contents of cast pipes will be found useful for reference:—

	2-Inch.	3-Inch.	4-Inch.
Ordinary lengths of pipe	6 feet.	9 feet.	9 feet.
Weight of same	32½ lb.	73 lb.	98 lb.
Contents ditto, about ..	7 pints.	11 quarts.	4½ galls.

It may occur to the reader to inquire why 2-inch pipe is not more often used in preference to 4-inch, as the former has exactly half the heating surface of the latter, and the quantity of water it holds is less than half, consequently a given heat can be obtained with a less proportion of fuel. 4-inch pipe is given the preference for the following reasons:—Firstly, that although it is more than double the time in heating, yet it remains hot very much longer than 2-inch after the fire is low.

It is very important in horticultural works that the temperature be as regular as possible, and the large bulk of water that 4-inch pipes contain does not readily show any irregular attention at the furnace. For residence works the smaller pipe would be used, and all modern radiators are constructed to afford a large heating surface with little water.

In residence works the plain cast pipe is now seldom seen, and radiators, of which there are such good designs and variety, are invariably used. These are connected up with wrought-iron pipes, these pipes not being relied on to furnish heat from their surfaces, but acting as distributors, conveying the hot water from the boiler to the radiators, where the heat is then diffused. All makers' lists of these goods furnish sizes and areas of surface that the radiators are made in, and for residence work it is usual to allow 14 feet of radiating surface to each thousand cubic feet of space in a living room, 10 feet in a bedroom and 18 feet in an entrance hall or cold passage. This is supposing no grate fires will be used.

It is hardly necessary to mention that incrustation or fur, a subject of considerable importance in "hot-water supply," does not occur in the boilers of this system, except to a very trifling extent, not worth notice, as the water is not changed often. There however occurs a deposit of dirt, &c., in the boiler or in any dip there may be in the return pipe. This deposit arises from various causes; for instance, dirt finds its way into the apparatus through the supply cistern, especially if it has no lid, and oftentimes the water that is used in a green-house is drawn by a gardener from some not over-clean tank or butt, and it is no uncommon occurrence to find pieces of leaves, &c., in the pipes. Therefore all boilers should be provided, not with manlids, but with a small (say 1½-inch) hole close to the bottom, each side, for flushing purposes. A pipe can be taken from these holes to the nearest convenient point for the water to pass out. When the apparatus is in use, these holes or pipes are plugged.

CHAPTER IV.

COILS, ETC., IN CONNECTION WITH A HOT-WATER SUPPLY APPARATUS.

HEATING coils, or a small quantity of pipe from the kitchen-range boiler is a plan often adopted, but certainly not to be recommended—the chief reason being, as already explained, the fact of the kitchen fire being out at night, when the heat is, in most cases, particularly needed. Another equally strong objection is, that to supply, say, three or four taps and two coils in the colder months, a moderately powerful boiler is needed, and this boiler in the summer months, when less warm water is required and the coils are out of use, is then a source of annoyance by its furious boiling. Furring also occurs in the circulating pipes connected to the kitchen boiler if hard water is used; and unless a sufficiently powerful boiler is used, the tank of water must be heated in the morning before the coil valves are turned on, otherwise there will be a deficiency in the hot-water supply when it is most needed. Therefore, in such a case as this, it would be particularly unsuited for a conservatory.

The methods shown in Fig. 20 are those generally adopted according to the position of the circulating pipes. Wherever circumstances will permit, a distinct flow and return service should be taken from the boiler for heating purposes, or at least a distinct flow, and utilise the supply return. This distinct service should be provided with suitable stop-valves and also draw-off service close by, so that the whole heating apparatus may be emptied during the warm weather, to prevent the extensive rusting which will take place when the water is still. There is no danger in putting stop-valves in this service, provided the hot-water supply service is open and clear from the boiler to the expansion pipe, *as it always should be.*

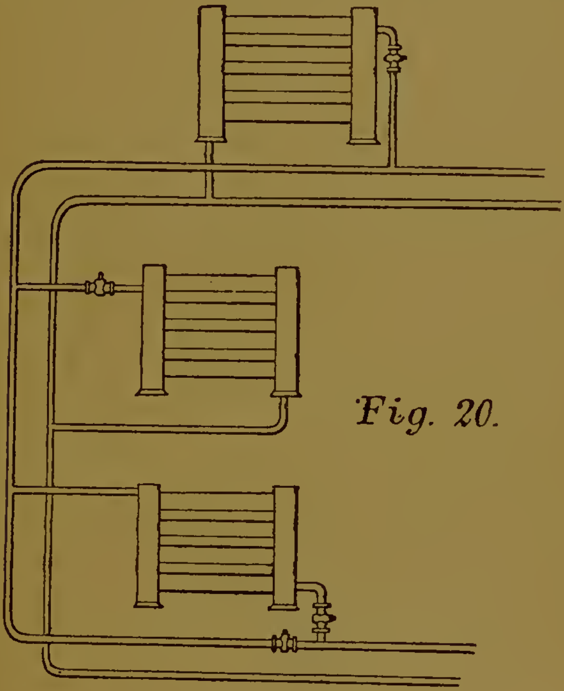


Fig. 20.

No other stop-cocks will be needed unless it is desired to shut off any particular coil when the others are in use, in which case this coil must have its own stop-valves; the illustrations show how the stop-valves may be placed. Each coil box should have an air-cock or pipe on top to admit of the air escaping when charging, and at other times. In horticultural work, air pipes are nearly always used, as the feed cistern is seldom more than 6 feet above the pipes.

CHAPTER V.

GENERAL DIRECTIONS FOR FIXING LOW-PRESSURE APPARATUS.

FIG. 21 illustrates a very ordinary arrangement, as might be fitted in the glass-houses of a gentleman's garden. The boiler is placed in any convenient position below the level of the circulating pipes, generally in a covered pit, having three or four steps leading down to it for the stoker's convenience, and this pit should, if possible, be situated in a position where it will be least seen. If it is not possible to form a pit for the boiler, it must be placed somewhere where its top will be a little below the flow pipe, as this pipe must start from the top of the boiler, and it should have a rise all along its entire length, if only 1 inch in 25 feet, but a little more for preference. If, however, no excavation can be made for the boiler and it stands on a level with the house, then the flow pipe must be carried to a small tank a few feet up, and the services carried from there to the different parts where the heat is required, providing practically one short flow and several returns, these latter doing all the heating required. We will, however, explain the ordinary direct system first, as it is seldom the other is resorted to.

In what may be called the "direct" system, as shown in Fig 21, the flow pipe is taken from the highest point in the boiler, and is carried from there by the most desirable route to the furthest point where the heat is required. This flow should have a rise of *at least* 1 inch in 20 feet. When it has been carried to its extremity, it is returned by bringing the return back immediately underneath it and connecting it into a low point in the side of the boiler.

A single flow and return is not sufficient for a hothouse, therefore they can be doubled (as illustrated) or trebled by using two- or three-way outlet syphons; the flow pipes all running on a level and parallel with each other, and the return pipes the same but immediately below the flow. The proper quantity of pipe for certain areas will be found in a table further on.

It will thus be seen that with ordinary care the general form of apparatus is easily fitted, and except

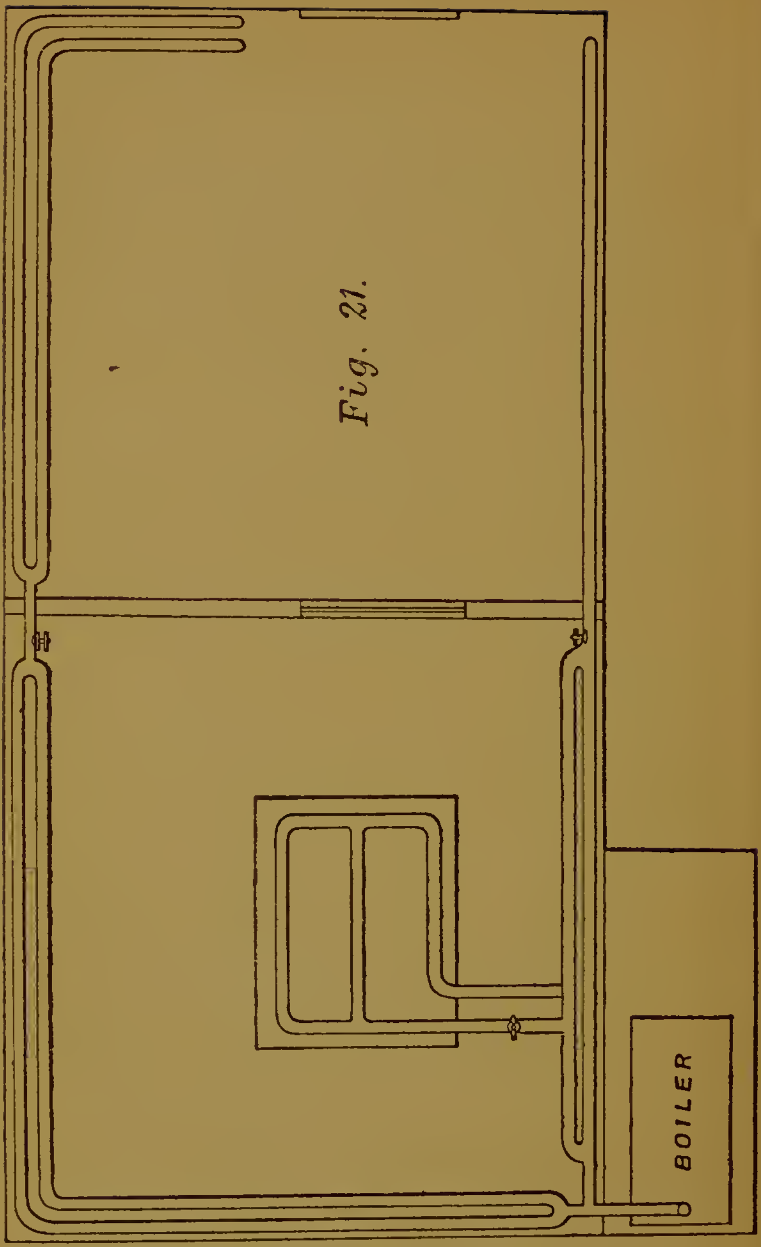


Fig. 21.

Flow pipes only shown in this illustration.

under unusual circumstances, good results must ensue.

Where one boiler heats two adjoining houses there must or should be means to shut off the heat from the further one when desired, without interfering with the other. This is usually done by inserting some of the various forms of junction pieces and stop-valves. In the last illustration an H pipe is inserted just between the two houses with cocks, as Fig. 22; this permits of the green-house being quite or partially shut off.

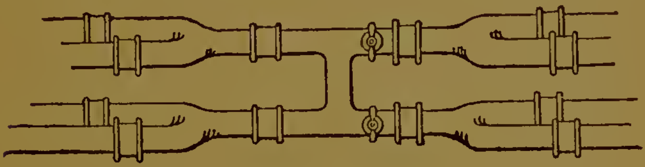


Fig. 22.

Fig. 21 also shows the flow-pipe branched near the boiler, one service being carried along one side and the other service being carried on the opposite side of the house. This would be done for two reasons, firstly, that the service could not be carried all round on account of the doorway shown, and secondly, it will be nearly always found that two short services work better than one long one. If desired, stop-cocks can be inserted to stop or check either of these services as desired, or as the weather dictates.

In the centre of the hot-house is shown a forcing or hot-bed; this generally consists of a pipe all round and one across. These pipes are covered with large stones, and the earth is placed on top; this permits of a proper heat being given as the moisture percolates through on to the pipes. The pipes under this bed are brought from the flow and carried back into the return (making another branch flow and return service), and should be fitted with stop-valves, as the regulation of the heat is of great importance.

There now come two further subjects of equal importance, viz.—the supply cistern and the air-cocks or vents. The supply cistern, in this system, should be fixed in any convenient position about 2 feet above the highest pipe. There is no stipulated size for this cistern, but it should be proportionate, and a good rule is to use one that has a capacity of say a thirtieth part of the whole contents of the apparatus. This cistern must not be quite filled, or it will overflow by the expansion of the water when heated. From the bottom of the cistern is carried a pipe, a piece of $\frac{3}{4}$-inch wrought tubing, and connected into the return pipe or boiler. This $\frac{3}{4}$-inch pipe should have a syphon in it to prevent the contents of the cistern becoming heated and giving off vapour (see syphon in cold-supply pipe in "Hot Water Supply").

Where the supply cistern is only a few feet above the whole apparatus it is best to fit air-vent pipes in preference to air-cocks, as the former permit of the free escape of air and steam, &c., without attention. These pipes should be carried up say two feet higher than the cold supply, to prevent overflow. It is sometimes difficult to determine the exact place in which to insert these pipes or cocks, as air will accumulate in every conceivable position; it is, of course, a standing rule to insert one at the highest points of the flow pipe, but there are sometimes places where air will lodge or stay as it travels along the pipes; a little care on the part of the fitter will overcome any difficulty in this direction. It must be clearly understood that the circulation will be impeded, if not wholly stopped, if there is any part of the apparatus where air can accumulate.

In fixing hot-water pipes of 2 inches diameter and larger, care must be used not to secure them tightly anywhere, as the expansion of the pipe itself lengthwise has to be considered; this expansion can be roughly calculated at 1 inch or 1¼ inch in every 100 feet. Therefore, if the pipes cannot move freely the joints will probably give way; the pipes should be supported loosely on brackets or brick piers; brackets can be obtained with a broad shallow roller where the pipe rests. Whatever support is used it must be a firm one, which will not sag down or sink in course of time, and so cause the pipes to be out of level. It is impossible in this short work to suggest the many ways of carrying services, even if it were attempted circumstances rarely permit of two apparatus being carried out alike; for instance, in Fig. 21 the boiler could, if desired, be situated in a pit just between the two houses (outside or underneath) and the flow then branch off from the top of the boiler in opposite directions by a tee piece, one service being carried to the forcing-house and the other to the green-house. This would perhaps be a better arrangement than that illustrated, as it would permit of a better use for the stop-valves, but it is not generally convenient to put the boiler at the side of the house.

In fitting stop-valves it must be understood that a valve must be put in both flow and return, otherwise the water may circulate to some extent up the pipe that is left open. If it is ever found that one valve will stop the circulation, it can be relied upon that the circulation is sluggish or imperfect by reason of the boiler being insufficiently powerful or from some other cause; in many instances, however, the valve in the return can be dispensed with by putting a syphon in this service, but the syphon must be fitted with a cap or plug at its lowest point, for the removal of the dirt that will be found deposited there.

It will be found that a syphon or dip in the return will have no prejudicial effect worth noticing, and it is oftentimes a convenience when the return is brought back another way and has to be carried under a doorway; but in ordinary cases this dip should not exceed 9 to 12 inches, and should only be made when the boiler is below the level of the house. There are pipes made especially for running under doorways, these pipes having a flat top with an ornamental pattern upon it; they can then be carried level and flush with the floor.

It should have been mentioned that with a properly fitted apparatus which has a good or moderately rapid circulation, the stop-valves can be of a smaller size. This is a source of economy, as the valves form a material item in the cost; for 4-inch pipe a 2-inch valve can be used, and for 3-inch and 2-inch pipe 1½-inch valves. This is somewhat a check to circulation, but it is the common practice, and care is only needed to see that the circulation is not likely to be imperfector sluggish, in which case full-size valves would have to be used.

The circulation is always aided by carrying the flow pipe vertically from the top of the boiler, and the circulation is always increased as the length of the vertical pipe is increased, and there should not be less than 12 inches in height between the flow and the return where they are inserted into the boiler. Where there are 3-inch or 4-inch branch flows taken from the main flow that leaves the boiler, the main flow need not be larger than its branches unless the apparatus is on an extensive scale, in which latter case the main flow might advantageously be made 6-inch if the branches were 4-inch, or 4-inch if the branches were 3-inch, but for general small purposes all the pipes can be of one size. The size pipes generally preferred are 4-inch or 3-inch for horticultural work, as the body of water being greater the heat is longer retained; and for domestic purposes 2-inch pipe, as it can be more easily hidden from view, and the body of water being less it is more quickly heated; for conservatories and glass-houses it must not be forgotten that trough pipes are commonly needed (or some other device answering the same purpose) to supply the very necessary moisture to the air, as the heat robs the air of the moisture it has naturally; but this care is not necessary in living apartments. Trough pipes are, as the name signifies, pipes with a shallow trough cast upon them, which is filled with water and which the heat causes to slowly evaporate; these troughs want continually filling, so that it is often arranged to have a larger wooden trough or shallow tank with one or two pipes carried through it.

The system of carrying the flow pipe direct from the boiler to a tank, which was referred to in the beginning of the chapter, is as follows:—The boiler can either be fixed below the house or upon a level with it; the flow pipe is taken from the top of boiler as usual, and is carried direct to a small tank, which is fixed say 4 or 6 feet above the height that the heating pipes will be run. From the bottom of this tank is carried what may be called the return pipes, which are the heating services, as at Fig. 23. By this system the use of stop-valves and air pipes or cocks is partially and sometimes wholly dispensed with, as no air or steam is generated in the pipes after leaving the tank, and if a service requires stopping or checking it can be done with a plug in the tank; the lid of the tank should fit moderately close and have a steam pipe in it.

This latter system has sometimes been adopted when heating two or three floors of a building from a boiler in the basement; the tank is then fixed just above the highest heating pipes, and the flow taken direct from boiler to tank as explained, and all coils and pipes, &c., connected off the return. This is said to facilitate the circulation, for instances have been quoted where the circulation has been reversed by reason of the great body of cold water that has to move upwards (when first heating up) when all the coils and pipes are taken off the flow.

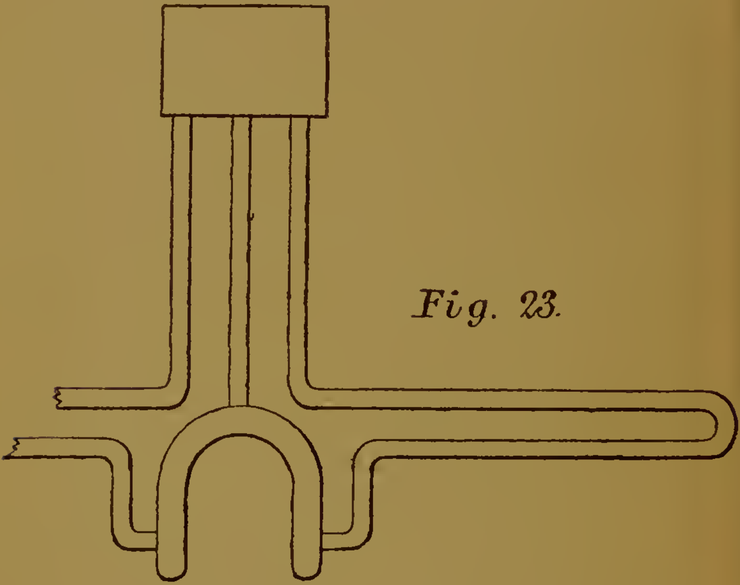


Fig. 23.

In heating churches, lecture rooms, and public places, where all the chambers, &c., to be heated are upon the same floor or level, the first-mentioned "direct" system is always used, and the pipes are carried in a similar manner to that described for glass-houses, the direction in which they are run and the branches, &c., varying with the circumstances. The pipes can be either carried round the walls just above the floor, but more usually a trench with a grated top (the top being level with the floor) is provided for the pipes to be run in, and sometimes, where the trench is not possible, one or two large flat coils of pipe are fixed below the floor and covered with an equally large grating; but the trench is preferable to this, as it permits of a more equal distribution of the heat. The method of running the pipes along the wall above the floor is, however, preferable to the trench in point of economy, though not in appearance. In making trenches for pipes the fitter must not fall into the error of having them too small; to permit of free radiation a trench for four 4-inch pipes should be at least 16 inches wide and 12 inches deep.

CHAPTER VI.

GENERAL DIRECTIONS FOR USING A LOW-PRESSURE APPARATUS, AND HOW TO FIND QUANTITIES OF PIPES FOR CERTAIN AREAS.

THE first duty is to charge the apparatus with water; this is done through the cistern, and when so doing all air vents should be open until the water flows through them freely, and of course all stop-cocks or valves must be full open at the same time.

A certain amount of care must be used in stoking, to keep the fire in and a regular heat during the night. The speed of combustion must be controlled, by the person who has charge, by regulating the damper, and it will quickly be found what amount of draught is best in general results. During the day the fuel may be used somewhat sparingly and be well spread over the bars; by this means a more perfect combustion is ensured, and supposing coal to be used, less smoke is evolved. At night the fire should be banked up in front with a mixture of small coal and coke, first moistened, and the damper regulated to check the draught and combustion. If care is not used in this latter respect, the apparatus will get overheated at first, and after the fuel is exhausted get quite cold, with disastrous results to the plants. This, of course, only applies to horticultural purposes, as with lecture halls, &c., there is no need to keep the fire going except for a few hours before and while it is tenanted. If a hall or church is not used daily, there should be a fire lighted each day in frosty weather, or the water may freeze and crack the pipes, unless the apparatus be emptied, which is still more trouble.

The fuel generally used is coke broken small, which should be well spread over the grate, not too thickly, but no part of the grate should be left uncovered, for the same reason that the upper door of the furnace front should never be left open, viz. to permit of the air passing in without first being heated by passing through the fire. In the larger boilers the bars do not reach right up to the front. There is a plain cast-iron plate lying between the furnace front and the bars, known as a "dumb plate." This plate is for banking-up purposes, especially if coal is used, the fuel being banked up on this plate in front, and any smoke or gas given off has to pass over the incandescent fuel and is consumed.

It should have been mentioned under the heading of boilers, &c., that the most lasting and best wearing form of bar is the ordinary fish-belly pattern, but having a groove or channel cast along the top lengthwise. The advantage is this, the groove quickly becomes filled with fine cinder and ash, which firstly prevents clinker adhering, and secondly, by ash being a poor conductor of heat, the iron is preserved to a considerable extent from the effects of the fire.

To ascertain the necessary quantity of pipe for heating certain areas for certain purposes, it must be first found what the inside cubic measurement of the building or apartment is; this can be readily calculated as follows :—Supposing it was a lecture hall with the usual square flat ceiling, you would multiply the length by the width and then by the height, as follows : room, 40 feet long by 25 feet wide by 20 feet high.

Length	40
Width	25
	1,000
Height	20
	20,000 cub. feet.

In the majority of cases the full height cannot be calculated, as green-houses, conservatories, churches, &c., do not have square flat tops, therefore it is a safe plan to calculate three-fourths of the height with sloping roofs thus :—Lean-to glass-house, 30 feet long, 12 feet wide, 12 feet extreme height.

Length 30
Width 12
———
360
¾ extreme height .. 9
———
3240 cub. feet.

Having found the cubical contents of the place, the following table will give the pipe or radiating surface required. One foot length of 4 in. pipe is calculated as one square foot of radiating surface if required.

Glass-Houses (Horticultural Works).

Temperature required. Degrees Fahr.	Length of 4-inch Pipe to each 1000 Cubic Feet Capacity.	
90	80	Forcing house.
85	75	
80	70	
75	65	Tropical house.
70	60	
65	55	Grapes, tomatoes.
60	50	
55	45	
50	40	Conservatory.
45	37	
40	35	Cuttings, stock.

For 3-inch pipes add one-third to the lengths given; for 2-inch pipes double the lengths.

For span houses add one-fifth to the lengths given.

Brick Buildings (Residence Works, &c.).

Temperature required. Degrees Fahr.	Square feet of radiating surface to each 1000 Cubic Feet Capacity.	
70	18	Entrance halls and passages.
65	14	Living rooms.
60	11	Bedrooms, schools, &c.
55	8	Stores, harness rooms.
50	7	Workshops.

CHAPTER VII.

HIGH-PRESSURE HEATING APPARATUS.

AN apparatus upon this system is composed wholly of small wrought-iron tubing, there being no tank or boiler in the proper sense of the word. This tubing is of a special strength to withstand the very high pressures; the size first used was ½ inch internal and 1 inch external diameter, but with this small pipe the friction was excessive with the very rapid circulation, and on this account engineers professing this work are now using a larger size, viz. $\frac{7}{8}$ inch internal and $1\frac{3}{8}$ inch external diameter, and the results are decidedly superior. The apparatus is constructed as follows:—Instead of a boiler a coil of the wrought tube is made and placed in the furnace, this tube being the same size and part of the circulating pipes; from the top of the coil the tube is carried wherever the heat is required, and then returned and connected at the lower end of the coil in the furnace, thus making to all intents and purposes a flow and return, the same as in other descriptions of hot-water apparatus; and the same rules have to be observed as to rising the flow, branch services, &c., but, as will be afterwards noticed, there are no supply cisterns or air vents.

At the highest point in the apparatus is fitted an expansion chamber; this consists of a piece of wrought tube of larger size (3-inch or 4-inch), some 2 to 4 feet long. This tube should be large enough to hold at least $\frac{1}{12}$th the contents of the whole of the small pipes, thus making ample allowance for expansion (which is very necessary by reason of the high temperatures attained). At the lowest point in the expansion chamber must be provided an opening for filling purposes, which opening is plugged after charging, so that when every opening is sealed up and the apparatus is ready for use the whole of the small pipes are full of water, but the expansion chamber has only air in it.

The following are the advantages of this system, and afterwards will be shown its many disadvantages. If the latter do not outdo the former in number, they certainly do in importance, and there are but a very few who profess this work, as great skill is needed in execution. In application this system is particularly convenient, as the smallness of the pipe permits it to be carried in positions that large pipes would be quite unsuited for; as, for instance, the entrance to inlet ventilating shafts can be fitted with a coil of small pipe which would be a next to impossible task with cast pipe; then again a small pipe can sometimes be fitted above the floor where a large pipe would be unsightly and have to be laid in trenches. There is no loss by evaporation, consequently no attention is needed in filling up cisterns, &c.

Very high temperatures can be obtained, and as much heat is, therefore, radiated from a certain length of this small pipe as from the same length of cast pipe, but with the advantage that the heat can be obtained much more rapidly on account of the small quantity of water to be heated.

The high temperature makes it especially applicable for drying purposes, and of course as the water is never changed there is no deposit, and the apparatus does not need opening for cleansing purposes.

Now the disadvantages. It must first be explained that a temperature as high as 600 degrees is attainable in an apparatus of this description at a near point to the boiler. This may to some readers be unaccountable, the very common impression with the uninitiated being that water cannot be heated higher than boiling point, viz. 212°. This latter impression is a correct one when the water is boiled in an open vessel, as the pressure of the atmosphere plays an important part in the action that takes place when water boils; but the water in a high-pressure apparatus is *not affected by the atmosphere*, and *it does not boil.* Consequently it goes on heating to a very much higher temperature than what is commonly known as boiling point.

To impress the reader that the pressure of the atmosphere regulates the boiling that takes place when water is heated to a certain temperature, it may be mentioned that water only boils at 212° at or about sea level; at a considerable distance up a mountain the pressure of the atmosphere is of course less than at sea level, and water therefore boils at a lower temperature, and there are some inhabited places in our Welsh mountains where water boils at too low a temperature to cook certain foods properly; while at the bottom of a deep mine the pressure is greater, and water boils at a few degrees higher than 212.

This is a considerable digression from the subject at issue; but to return, it is to be noticed that the high temperature has many disadvantages. It is dangerous for any one's hands or body to come in contact. It is injurious to many things, as 600° (if accidentally attained) is not such a very great way from red heat, and is, therefore, unsuited for horticultural work unless the pipes are kept a good distance from the plants. If two or three branch services are closed off at once the boiler (coil) instantly becomes too powerful, an enormous pressure is exerted, and the heat becomes quite dangerous unless the stoking is carefully done; the great heat makes the air in a state of unhealthy dryness, unless vaporising pans are provided, and unpleasant smells and tastes are sometimes experienced, which are caused by the small particles of matter that float about in the air as dust, coming in contact with the pipes and becoming scorched or melted according to their nature. There is a great strain exerted by the unusual expansion that takes place in the metal itself, therefore the pipes must not be fixed tightly to their supports.

It should have been mentioned earlier that as very high temperatures and pressures are the chief objectionable features, the coil acting as boiler must be proportionate to the size of the apparatus; a good size is to make it of $\frac{1}{10}$th of the pipe forming the apparatus, i.e. if 500 feet of pipe was required, use 50 feet for the coil boiler.

The pipe used for this purpose is tested to withstand a very high pressure, but this does not overcome the fact that, with the intense heat there is, a change takes place in the nature of the iron itself, it losing its fibrous texture somewhat. If an accident occurs, it is generally by the pressure splitting the pipe; it is not so dangerous as the bursting of a kitchen-range boiler, but it would no doubt seriously injure any persons if they were close by when the fracture occurred.

In conclusion, except for special requirements, the low-pressure system is preferable in general results, and none but really skilled mechanics should attempt to fit a high-pressure apparatus, as the joints need the greatest care in making, and the charging requires to be properly done, as no air must be left in the small pipes, which must be *quite full.* A pump is used in the filling.

The writer does not wish to convey that this system *cannot* be fitted in a proper and satisfactory manner, but it is certainly not an undertaking suited for those that have not had experience in *this particular* branch of mechanics. There are several firms of considerable repute who undertake this work and guarantee the utmost efficiency.

STEAM COOKING APPARATUS.

CHAPTER I.

INTRODUCTION. BOILERS, SUPPLY CISTERNS, ETC.

Many eminent authorities have been of opinion that cooking by steam would for many general purposes supersede all other methods. The results are certainly superior, especially with vegetables, as many people know by that very familiar vegetable, the potato. This is acknowledged to be better when steamed than when boiled; there are also many meats that are at their best when cooked in steam.

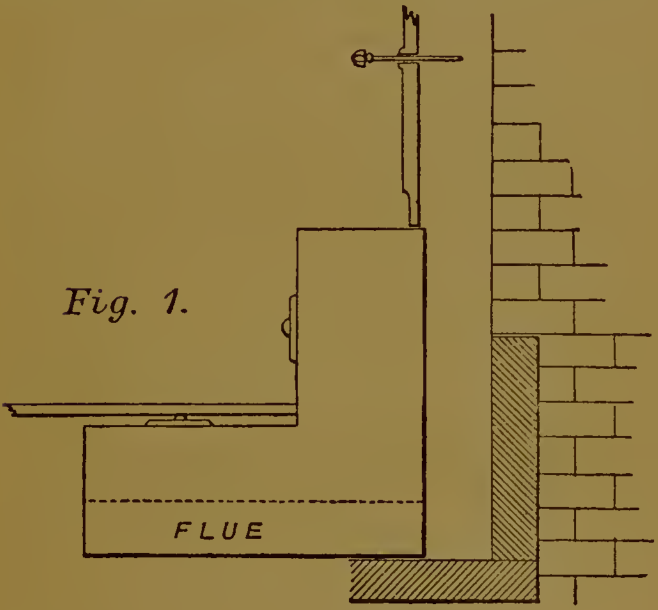
It is with many a common idea that whatever is cooked in this manner must be wet and soddened, and consequently very unpleasant to the sight as well as taste, but this idea is a very erroneous one as experience would prove. Steam resembles a hot gas, and has no moistness until it is cooled, when it condenses to its original form, viz. water. Therefore, whatever is cooked in steam may be said to be cooked in very hot air (but with better results), and has no moisture other than that which naturally proceeds from meat, or whatever may be cooked.

Cooking by steam is much cleaner, more rapid and convenient, also more economical than boiling or roasting, and even where only a moderate amount of cooking is done it can be recommended.

The boiler can be placed in the scullery (if it is not fitted in the kitchen range), or even in an outhouse if convenient for stoking, this usually being done by the cook, except in large establishments; and the steam kettles, hot closets, &c., are ranged round the kitchen.

THE BOILERS can be had in nearly any form to suit the requirements of the case. We will, however, first speak of those used in the kitchen range. These boilers can never be made very large, consequently their power and the amount of work they will do is limited, and they should only be used as auxiliaries to the other cooking apparatus. These boilers are usually made "boot"-shaped, with a flue underneath, as Fig. 1; sometimes the flue is continued up the back (as Fig. 2 in "Hot Water Supply"), but more usually the flue up the back is constructed in brickwork (or iron), the back of the boiler forming the front side of it. It will be noticed that Fig. 1 shows the leg of the boiler projecting or standing out on the hot plate of the range; by this arrangement the use of a supply cistern is dispensed with, as all the fittings can then be attached to the boiler itself, as at Fig. 2. If the range is such that the boiler must be fixed where it cannot be seen (under the hot plate and behind the coving plates), a supply cistern must be used, to which the fittings are attached, as not only must they be in sight, but they must be kept clean and occasionally tested.

Fig. 1.



These boilers are made of $\frac{3}{8}$-inch wrought plate, welded at the joints, and if boot-shaped they must have two manlids, the upper one being of full size to

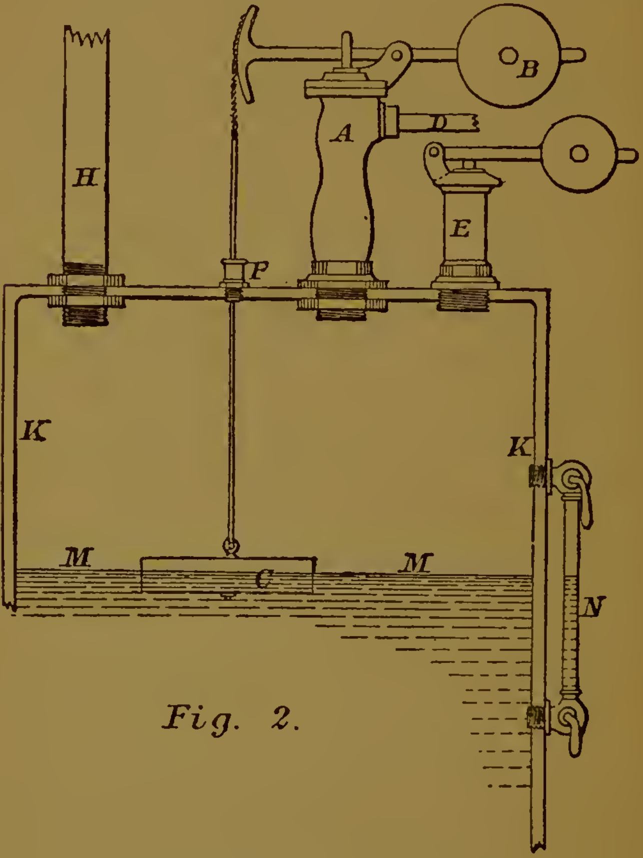


Fig. 2.

allow of the stone float being passed in and the connections being made.

Incrustation or fur accumulates in these boilers nearly as fast as in boilers for hot-water supply, and the directions given upon this subject under this latter title must have every consideration and attention, or the boiler will certainly become fractured. The reader will understand, as has been explained when treating the subject, that this incrustation and all its ill effects only occur when what is known as "hard" water is used, that is, water that has lime or chalk in it. (The lime or chalk is quite invisible to the eye, and the water generally has quite a crystal clearness.)

It will be seen by Fig. 2 that the boiler is arranged to fill about three-fourths full, the remaining fourth being the steam chamber.

When boilers are set in brickwork with the necessary furnace, &c., they are sometimes used boot-shaped, but more commonly a kind of saddle boiler is used with extra wide waterway at the top, which is arranged to be but partially filled. And there is the "waggon" boiler, a shape specially made for steam cooking; both the latter are made in all sizes up to 5 feet long, and are very powerful.

A very useful style of boiler for domestic purposes, but which, however, is but little made, is an independent steam-cooking boiler. These can be had with fittings all complete, and only need connecting with the work and with the flue, &c., to be ready for use.

THE SUPPLY CISTERNS are cast-iron boxes of good strength, and when the fittings are attached they must have manlids. It might be mentioned that many people use a cistern whether the fittings can be put on the boiler or not, as they consider that a drier steam is obtained thereby. The writer must acknowledge that, although he has investigated the question, he has not been able to discern any superiority in the steam from a cistern with small and medium-sized apparatus. Dryness is an essential feature in steam for cooking, and if the boiler is sufficiently powerful and *no heat is lost anywhere* (from pipes, &c.), the fitter can safely take his steam direct from the boiler.

Steam-supply cisterns are fitted on a level with the boiler; this arrangement is best, as the water inlet valve can then be fitted in the cistern, as also can the water gauge. The safety valve, however, should be in the boiler or connected direct with it by a short pipe. The cistern is placed level with the boiler, and a pipe is carried horizontally between it and the boiler above the water level, say 2½ inches from the top. Another pipe is then carried in a line with the other, but below the water level, say 4 inches from the bottom. The two pipes are necessary to equalise the pressure, and there are no further connections between boiler and chest.

CHAPTER II.

PIPES, PRESSURE, FITTINGS, VALVES, ETC.

THE pipe used for this purpose is the red steam tube already referred to; this is of ample strength, as very little pressure is exerted, seldom more than 10 lb. to the square inch, except when the apparatus is on an extensive scale and special cooking utensils are used. The ordinary steam kettle (cooking pot) is not made to stand much pressure—being made of tin, with the lid only slightly secured—and a pressure of 5 lb. is sufficient to ensure the necessary dryness.

The fittings in connection with the boiler or cistern consist of *Water Inlet Valve* A, Fig. 2. This valve is connected with the water supply by a union at D, and the inflow is regulated by the arm at top balanced by the weight B and the stone float C. A wire connects the arm and the float, and this wire passes through the stuffing box F ; the wire must work freely, and must on no account bind or stick.

It has already been explained that the pressure or weight of water in pipes is 1 lb. to every 2 feet 4 inches in height, therefore the cold-water cistern in connection with the union D must be at least 25 feet above it for 10 lb. pressure of steam ; for when the valve is opened the steam immediately exerts itself, and if with a pressure of 10 lb. and the cistern only 20 feet above the boiler, the water, instead of flowing into the boiler, would be blown back into the cistern by the superior pressure of the steam, as the column of water in 20 feet of vertical pipe would only be equal to about 8 lb. pressure to the square inch.

With small boilers fitted in kitchen ranges in which the pressure is very low, the ordinary type of supply cistern can be used for the water supply, but the dip, or syphon, in the pipe must be deep enough to withstand the pressure of the steam, and the supply cistern should have a close, tight-fitting lid.

The Safety Valve E, Fig. 2, is the description generally used ; spring valves are not quite so suitable for this work. Dead-weight valves, having a series of weights that can be placed on the top of the centre pin, are sometimes preferred, but the writer considers the lever form (as shown) quite satisfactory.

The Water Gauge N, Fig. 2, is, as will be seen, two cocks screwed into the side or the front of the boiler (or cistern), one above or one below the water-level M; a glass tube extends between these cocks, and when clear the water passes into the tube from the boiler. The height of water is indicated upon the principle that two bodies of water, however unequal in bulk, if connected, both quickly become of exactly the same height or level. Of course both cocks must be open, otherwise the gauge will not be reliable, in fact, the only time to close these cocks is when by accident the glass tube is broken; if it were not for this mishap the cocks would not be needed.

The Pressure Gauge is not shown, as it is seldom used except with large apparatus; its object, as its name denotes, is to indicate the pressure of steam per square inch that exists in the boiler.

The Steam Pipe, which conveys the steam from the boiler to the work, is simply connected at a high point in the boiler, as shown at H, Fig. 2; K is the boiler plate and M is the water level.

Stop Valves, which are inserted in the steam pipe to shut off branch services when not in use, are made in several qualities; they are usually screw-down diaphragm valves with wheel handle, commonly known as "wheel steam valves."

CHAPTER III.

GENERAL DIRECTIONS FOR FITTING; CONDENSE WATER; SYPHONS AND SYPHON BOXES; WATER HEATING, ETC.

As the steam travels from the boiler to the various utensils there is a certain loss of heat, and consequently a portion of the steam becomes condensed into water, therefore the best way to carry the steam services is to keep them rising after they leave the boiler, so that all water will run back into the boiler as fast as it is condensed; but this arrangement cannot always be carried out, as some of the work may be below the main service, in which case the condensed water would run down into the cooking utensil unless a syphon or trap is provided to catch it.

The syphon is the ordinary form of inverted syphon fitted at the lowest point in the service; the syphon can have an open end if it is deep enough to withstand the pressure of the steam, and will thus be self-acting, as Fig. 3; but if it cannot be made deep it must have a closed end and have a tap in it to draw the water off periodically, or, instead of a syphon, a larger piece of pipe would do, or, better still, a properly made syphon box, which is made expressly

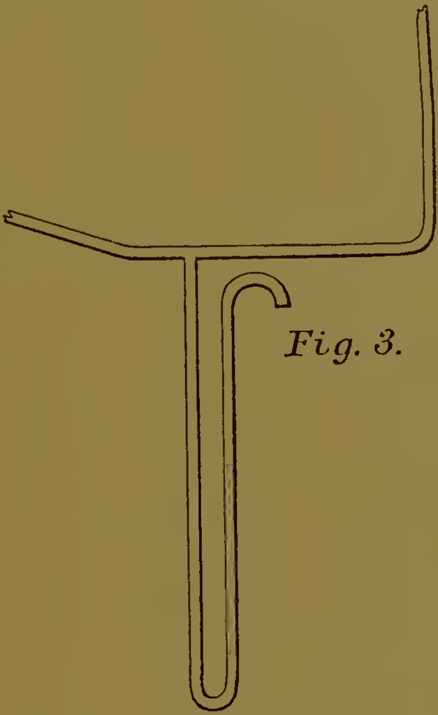


Fig. 3.

for this purpose. This subject requires every attention, as the condensed water *must* be kept out of the pipes.

Where services are of any length it will be found decidedly advantageous and economical to cover them with some non-conducting material to prevent loss of heat and the consequent condensation.

The connection of the pipes to the utensils need not be spoken of, as it is merely the screwing together of pipe and union; but it must be seen that every utensil has a stop-cock to control the heat, they are usually provided ready fitted with cocks.

Opinion is somewhat divided as to what method should be adopted for heating water by steam. It is a recognised fact that the most rapid and economical method is to discharge the steam directly into the water that is to be heated; but this method has two serious disadvantages, which makes it sometimes unsuitable even for the least particular business purposes (coffee-houses, &c.). In the first place, if the boiler is of usual power the discharge of steam into the water will cause a somewhat furious disturbance and noise, which would quickly be objected to unless the tank was in a secluded corner. There have, however, been one or two means suggested to modify this noise: one is to close up the end of the pipe that goes in the water and bore a number of small holes in it, so as to diffuse the steam somewhat; another method is to fix a sort of box or case at the end of the pipe in the tank, this box to have holes drilled in it and to be filled with large shot or small bullets. There is, however, another objection besides the noise, as follows: immediately the boiler is out of use and cools down, all the steam in the pipe condenses; as soon as the steam condenses in the pipe between the boiler and the hot-water tank, a vacuum is formed (as there is no air in the service pipes) and syphonage sets in, drawing the water out of the tank into the boiler, which it fills, and probably fills some of the other service pipes. This can be avoided by putting a stop-cock or check valve in the tank service, which must be closed immediately it is out of use. It will be seen from Fig. 4 that when the tank is above the boiler the service between them forms a true syphon.

It will be seen, therefore, that there are but few instances in which the economical method of discharging the steam directly into the water can be adopted; it is, therefore, more usual to use either a closed coil, or a coil having its open end terminating outside the tank. The closed coil is generally a coil of pipe as large as can conveniently be got into the tank, the upper end being closed and the lower end being connected with the boiler by the service pipe. Many may ask, Where does the steam pass to if the end of the coil is closed? It does not pass at all, the coil being kept at a lower temperature than steam by the water surrounding it, the steam is condensed as fast as it arrives in the coil, and the condensed water trickles back into the boiler, so that there is a continuous supply of steam to the coil, which parts with its heat, condenses, and makes room for a fresh supply; there is, however, a grave objection to this method if the service pipe cannot be carried with a regular rise all the way, as the condensed water must not accumulate anywhere.

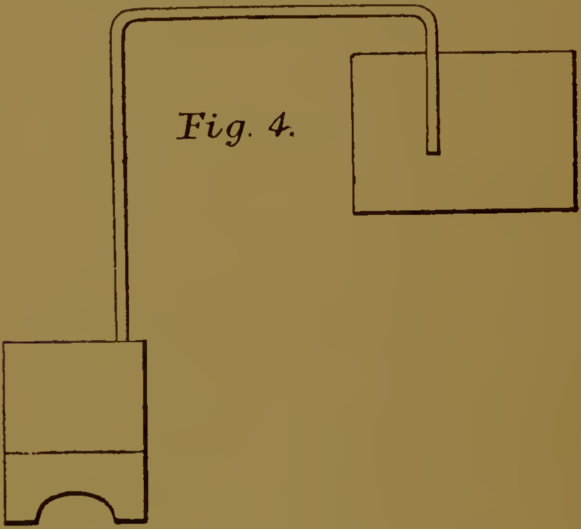


Fig. 4.

Instead of using a closed end coil, a coil can be placed in the tank and the steam service connected at its top extremity, and its lower end carried through the tank and a deep syphon connected with it; this syphon catches all condense water, and if it is of sufficient depth it prevents the steam blowing out. Provision must be made to carry away the water that is continually dribbling over the open end of the syphon, and of course the open end of the syphon must not be higher than the bottom of the tank, as the coil must be kept clear of water. Sometimes the syphon is dispensed with, and the steam allowed to blow out into the air after passing through the coil, but this, it is unnecessary to add, is very wasteful.

No general rule can be given as to what size boilers are required for certain work, but for domestic purposes this experience can be quickly gained. It will be found that a boot boiler in a kitchen range with 11-inch fire will work three or four kettles and a hot closet. When providing a boiler for a business house, always first ascertain what vessels will be used; if there are any "jacketed" utensils, they must be allowed double as much steam as those that let the steam act direct on their contents. A jacketed utensil is one that has an outer casing into which the steam is conveyed, no steam entering the inner vessel where the meat, &c., is.

It will be found that a steam cooking apparatus on a small scale is a moderately simple undertaking, and with ordinary care there need be no fear of failure.

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